

Thorax CT findings of temporal changes in a case with COVID-19 pneumonia

Thorax CT in COVID-19 pneumonia

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Coronavirus disease 19 (COVID-19), which has recently become a worldwide pandemic with high mortality, causes severe pneumonia. The major routes of transmission of this disease are direct inhalation of respiratory droplets or contact with surfaces contaminated with them. Its definitive diagnosis is made by a real-time PCR test. Radiological methods, especially computed tomography (CT), play an important role in supporting the diagnosis and determining disease stage and complications. In this paper, we report the CT findings of COVID-19 pneumonia at different disease stages in a patient diagnosed with the disease, and we provide a discussion of the relevant literature.

Keywords

Coronavirus; Computed tomography; Lung; Pneumonia

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Introduction

Coronavirus disease 19 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a coronavirus strain known as 2019 novel coronavirus (2019-nCoV). The COVID-19 disease, which first appeared in December 2019 in Wuhan, the capital of China's Hubei province, has since then gradually turned into an important worldwide pandemic. According to the World Health Organization, more than 40 million cases and more than 1 million deaths have occurred so far. The most common clinical findings of COVID-19 are fever, dry cough, and fatigue. However, in some patients, it has been described to produce atypical findings such as myalgia, diarrhea, conjunctivitis, anosmia, and central nervous system symptoms. The definitive diagnosis of COVID-19 depends on the real-time polymerase chain reaction (RT-PCR) test performed on nasopharyngeal swab samples. However, this test is flawed by low sensitivity, especially in the early stages of the disease (minimum 60-70%, maximum 95-97%). Radiological methods are not diagnostic for COVID-19 but aid in making a diagnosis and eliminating differential diagnoses. Waiting for PCR test results for periods exceeding 24 hours may sometimes create diagnostic problems. In contrast, computerized tomography (CT) with readily available results plays an important role in the diagnosis and management of COVID-19 when a combination of typical CT and clinical findings is used [1-4]. American College of Radiology (ACR) recommends against the use of CT as a first-step screening test or a first-step diagnostic test for COVID-19. According to ACR, CT should be used only in a limited fashion, to be spared for hospitalized symptomatic patients with specific clinical indications [5]. In this paper, we report a case of COVID-19 confirmed by the RT-PCR test in a 64-year-old man, which showed different patterns of CT findings of lung involvement over the follow-up course.

Case Report

A 64-year-old man presented to the hospital with headache, malaise, loss of appetite, and myalgia. He had a clear history of contact with the epidemic area. His spouse's RT-PCR test and thorax CT findings were positive for COVID-19. He had no cough, fever, running nose, or diarrhea. At admission, he had a body temperature of 36.6 °C, arterial blood pressure of 110/80 mm Hg, a pulse rate of 85 beats per minute, a respiratory rate of 20 breaths per minute, and an O₂ saturation of 95%. His physical examination was notable for rhonchi over both hemithoraces. His laboratory tests results were as follows: C-reactive protein 6.8 mg/L (normal: 0-1 mg/L), erythrocyte sedimentation rate 34 mm/hour (normal: 0-20 mm/hour), lactate dehydrogenase 342 U/L (normal: 135-225 U/L), blood lymphocyte percentage 15 (normal: 15-43%). Other laboratory parameters were within the normal range. A plain chest PA radiogram taken for presumed pneumonia revealed ground-glass opacities in both paracardial areas. A low-dose unenhanced thorax CT taken to confirm the diagnosis showed opacities of ground-glass density with a tendency to coalesce in both lungs, particularly in the posterior and lateral segments of the lower lobes, accompanied by vascular dilations (Figure 1 A, B, C). Since the signs on admission CT were suggestive of COVID-19 pneumonia, a real-time PCR test was sent, which returned positive. The patient was started

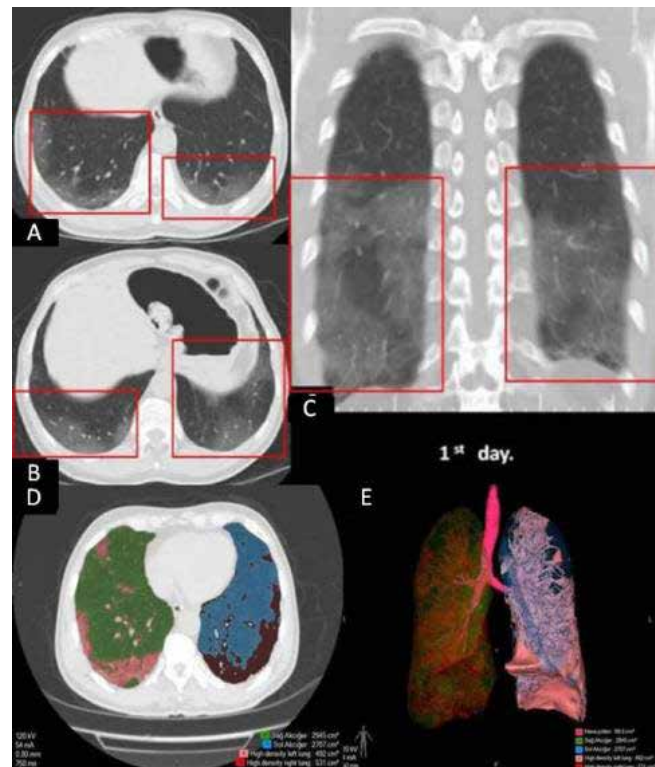


Figure 1. In a low-dose unenhanced thorax CT examination performed at admission, the axial images (A, B) and a coronal reformatted image (C) show bilateral opacities of ground-glass density with a tendency to coalesce and concomitant vascular dilation, especially in the posterior and lateral segments of the lower lobes (red frames). These CT findings are compatible with stage 1 COVID-19 pneumonia. (D) Axial colored-reformatted CT image demonstrates bilateral opacities of ground-glass density at posterior and lateral segments of the lower lobes. (E) Three-dimensional volumetric thoracic CT image shows the volume of bilaterally affected lung areas.

on hydroxychloroquine, oseltamivir, moxifloxacin, and supportive oxygen therapy. Since his clinical examination, performed eight days after admission, showed that his malaise and poor overall condition persisted, and his body temperature rose to 38.2 °C, a repeat low-dose nonenhanced CT was performed. The latter showed that the opacities of ground-glass density found in both lungs became more diffuse, which were now accompanied by patchy areas of consolidation and interlobular septal thickening (Figure 2 A, B, C). No concomitant mediastinal lymphadenopathy or pleural effusion was noted. A decision was made to continue the existing treatment. The patient was discharged on the 12th day of admission upon observing that his clinical and vital signs were stable. He was instructed about the isolation rules. A control CT examination performed three weeks after admission showed that the ground glass opacities and areas of consolidation were markedly resorbed, and they were now accompanied by parenchymal fibrotic changes and subpleural linear streaks at the same locations (Figure 3 A, B, C). A COVID-19 specific three-dimensional (3D) volumetric CT evaluation was made for the patient on a separate workstation (Myrian® COVID-19 Protocol version 2.0). On admission, this evaluation revealed that the lesion involvement volume due to COVID-19 pneumonia was 531 cm³ in the right lung, and 492 cm³ in the left lung (Figure 1 D, E). On the 8th day, the lesion involvement volume due to COVID-19 pneumonia was 408 cm³ in the right lung, and 382 cm³ in the left lung (Figure 2 D). On the 21st day, the lesion involvement volume was 346 cm³ in the right lung, and 320 cm³ in the left lung. As the patient's clinical

and laboratory findings were entirely normal at the final visit, the treatment regimen was stopped. His latest RT-PCR test returned negative for COVID-19.

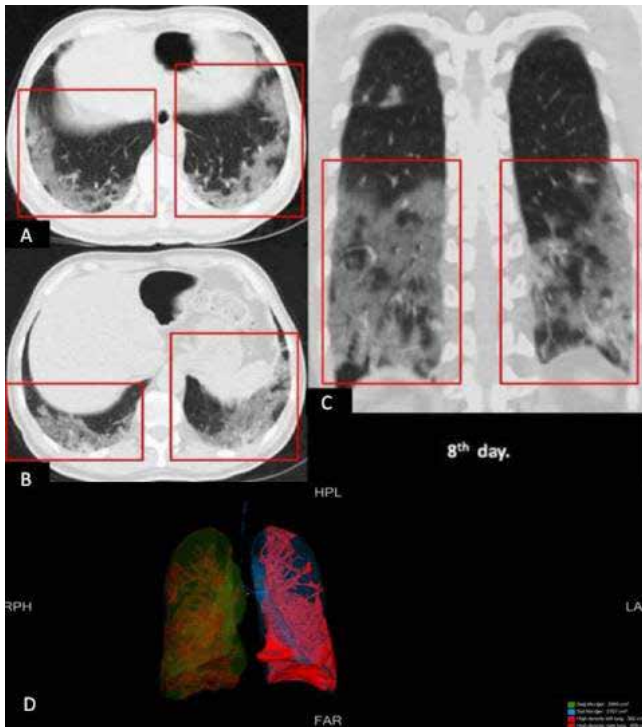


Figure 2. In a low-dose unenhanced thorax CT taken on the 8th day, the axial images (A, B) and a coronal reformatted image (C) show an increased diffuseness of opacities of ground-glass density with concomitant patchy areas of consolidation and interlobular septal thickening (red frames). These CT findings are compatible with stage 2 COVID-2 pneumonia. (D) Three-dimensional volumetric thoracic CT image demonstrates the volume of bilaterally affected lung areas.

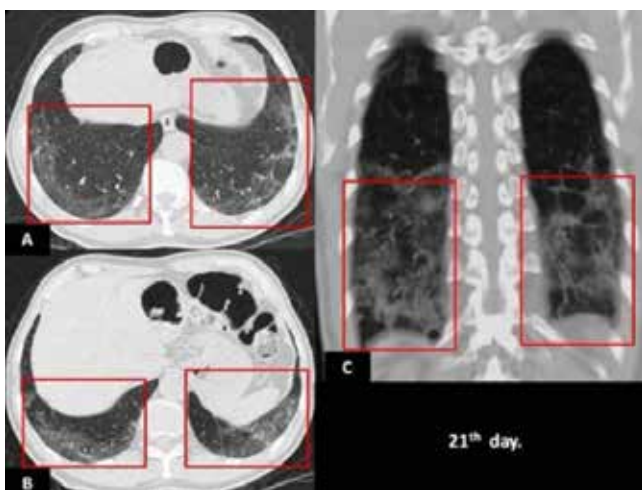


Figure 3. In a low-dose unenhanced thorax CT taken on the 21st day, the axial images (A, B) and a coronal reformatted image (C) show markedly resorbed ground-glass opacities and concomitant areas of consolidation involving both lungs, with parenchymal fibrotic changes and subpleural linear streaks now accompanying the above findings in the same locations (red frames). These CT findings are compatible with stage 4 COVID-19 pneumonia.

Discussion

Plain chest radiogram and CT are imaging modalities that can be used for the diagnosis and follow-up of COVID-19 pneumonia. The advantages of portable chest x-rays are bedside availability, easy sterilizability, and are especially suitable for children, young adults, and pregnant patients. Nevertheless, plain radiograms may show normal findings in the early stages

of COVID-19 pneumonia. CT, on the other hand, plays an important role in determining disease stage, diffuseness, and complications as well as eliminating noninfectious conditions. Recent studies have indicated that CT has a sensitivity of 60-98% and a specificity of 25-53% for diagnosing COVID-19 pneumonia [6]. The major CT signs of COVID-19 pneumonia have become very well-known thanks to a plethora of studies conducted since the publication of the first study on the topic on 31 January 2020 [7]. In addition, an increasing number of studies are constantly being added to the literature. The major early signs of the disease are bilateral subpleural peripheral ground-glass opacities, and late signs include airspace consolidations and bronchovascular thickenings. Consolidation is observed especially in the elderly and in a lower number of cases. Consolidations may at times be superimposed on ground glass opacities in the early stages of the disease. COVID-19 pneumonia more commonly involves basal and posterior segments of the lungs, with middle lobes being less commonly involved. The upper lobes may be rarely involved. In addition to these basic findings, a wide range of other signs such as cobblestone appearance, tree-in-bud appearance, reverse halo sign, air bronchogram, subpleural streaks, vascular dilation, bronchiectasis, pneumothorax, mediastinal lymphadenopathy, pleural effusion, and pericardial effusion may also be observed in COVID-19 pneumonia [3, 4, 6, 7]. There are several studies on the temporal radiological evolution of COVID-19 pneumonia in the current literature [8, 9]. According to those studies, CT findings of COVID-19 pneumonia evolve in four basic stages [9, 10].

Stage 1 - (Early Stage, 0-4 days); the major CT finding in this stage is ground glass opacities commonly found in the lower lobes and posterior segments. Our patient had similar CT findings at admission.

Stage 2 - (Progressive Stage, 5-8 days); this stage is characterized by progressive ground-glass opacities added with patchy areas of consolidation, increased prominence of bronchovascular structures, and thickened interlobular and intralobular septa. Our patient had similar findings on a CT examination taken 8 days after his admission.

Stage 3 - (Peak Stage, 9-13 days); this stage is characterized by an increase in the intensity of consolidated areas and the appearance of the signs of secondary complications. This stage contains fewer specific signs for the pulmonary involvement of COVID-19. Similar findings may be observed in cases of atypical and viral pneumonia, mainly organizing pneumonia. Our patient showed no CT findings of this stage.

Stage 4 - (Absorption Stage, ≥ 14 days); this stage is characterized by a gradual resolution of pulmonary lesions. The most notable signs pertaining to this period include a marked decrease of the diffuseness of the areas of consolidation, but the emergence of cobblestone appearance and parenchymal fibrotic bands mainly of subpleural location. Our patient's CT examination taken on 21st day also showed marked resorption of areas of consolidation with added parenchymal fibrotic changes and subpleural linear streaks in the same locations. Some studies have argued that parenchymal fibrotic bands and streaks may be a characteristic of the resolution stage and indicative of disease stabilization.

3D CT lung volumetric examination gives an estimate of the total lung volume and the volume of affected areas due to COVID-19 pneumonia using CT density thresholds with mathematical algorithms available at the workstation. This method is an easy-to-apply method, and can be used in the follow-up and response to treatment of lung areas affected by COVID-19 pneumonia.

Conclusion

This case report describes three different temporally evolving constellations of thorax CT signs that appeared during the initial and recovery phases of a case with COVID-19 pneumonia. In cases with COVID-19 pneumonia thorax CT provides valuable information about the stage, diffuseness, course, and potential secondary signs of the disease. However, it is not appropriate to use thorax CT as the initial diagnostic modality to replace RT-PCR. Future clinical-radiological studies with long follow-up periods and large patient populations will guide efforts directed at a better understanding of the radiological signs of COVID-19.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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